Gold Mineralization Potentialities in (RS-12V)

Arbaat locality, Read Sea, Sudan

Submitted to: BN energy company Ltd

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Introduction:

1.1 General

BN ENRGY COMPANY LTD dually registered company by the Government of Sudan represent Ministry of Minerals for exploration and exploitation of Gold and associated minerals in block RS-12V in the Red Sea State. The area of study has been investigated during a field trip generally oriented using Remote Sensing techniques and GIS to study the exploration in regional geology, and geochemical survey to identify potentiality of gold and associated metals mineralization

BN company was awarded (264 Km^2) Concession for exploration and exploitation of Gold & Associated Metals in Block RS-12V the area located in the Red Sea State ARBAAT, locality.

Prospecting and Exploration activities have been completed in full swing with a dedicated team of national geologists. The findings thus far are promising and the general exploration and evaluation in substantial form will continue based on the findings of this completed the first phase of exploration. The area of study has been investigated during a field trip generally oriented using Remote Sensing techniques and GIS to study the regional geology, and geochemical survey in large scale Reconnaissance exploration and identify potentiality of gold and associated metals mineralization then detailed exploration to determination different target in concession block from the results of samples collected from surface/subsurface and geological interpretation in the field.

BN mining company has engaged the technical aid of Team of geo consultancy to achievements the complete the field trip of exploration program for concession area.

1.2 Property description and location

Sudan is located along the northeast coast of Africa on the Red Sea, and is bordered to the east by Ethiopia and Eritrea, to the north by Egypt, to the northwest by Libya, to the west by Chad and the Central African Republic, and to the south by South Sudan.

The BN company concession (RS-12V) located in a the area within the Red Sea State east of Sudan, at the area of Arbaat red sea state, approximately 40 km north west of port Sudan and 20 km west of Atbaat market.

From Port Sudan the License area can also be accessed via the Port Sudan road to Arbaat paved asphaltic road and then via unpaved road crossing flat and rocky area, to the block site .

Generally the area is easy accessed from port Sudan to the site throw Agabat Yas road

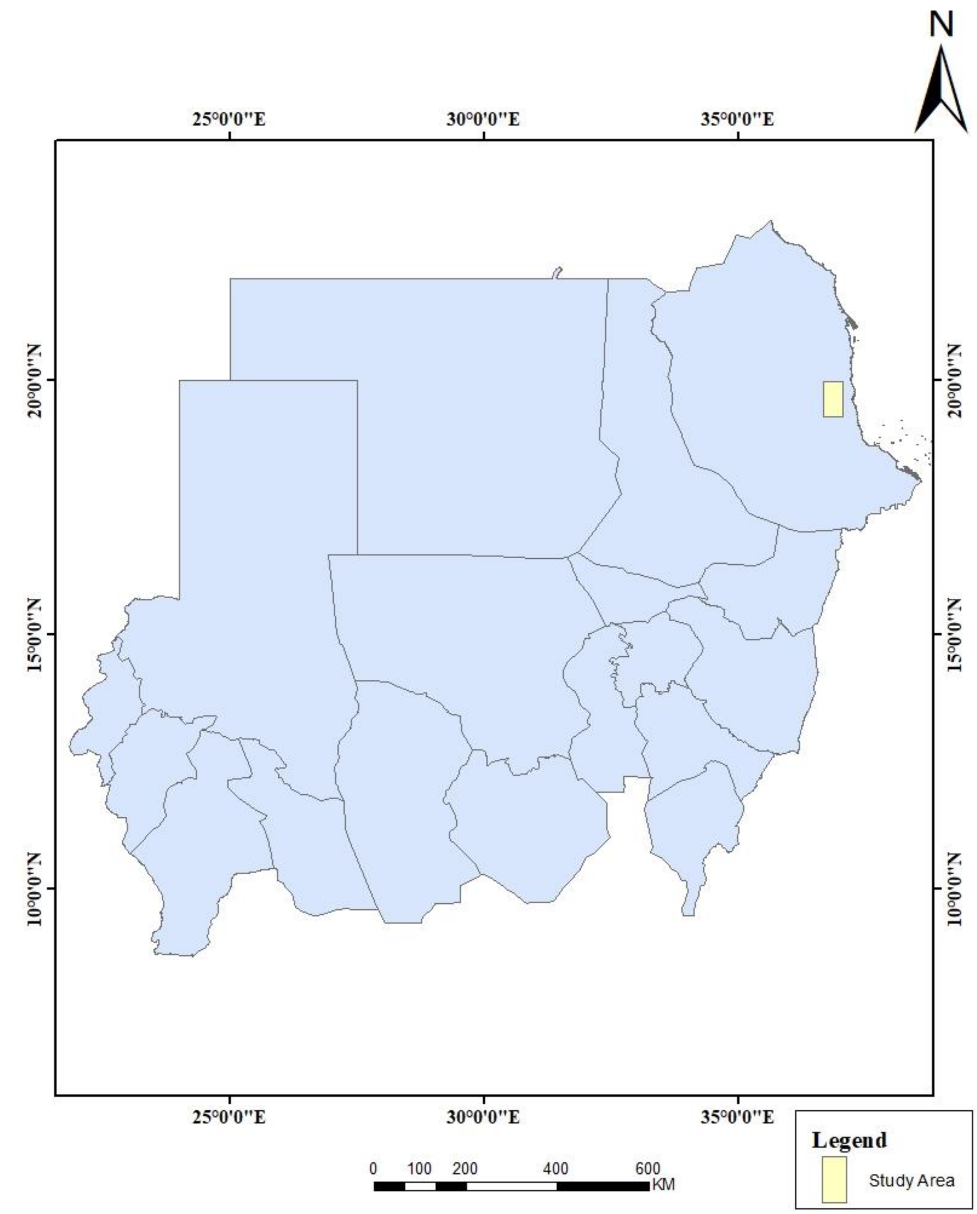


Figure (1): Location map of BN Mining Company.

Table .1 showing the corner coordinate of Block R12V

Block no	corner	Longitude			Latitude			Area(KM²)	State
RS12-V	A	36°	51'	36.600"	19°	45'	40.000"	264	Red Sea
	B	36°	57'	21.600"	19°	45'	40.000"		
	C	36°	57'	21.600"	19°	31'	26.400"		
	D	36°	51'	36.600"	19°	31'	26.400"		
	BN ENRGY COMPANY LTD								

1.3 Climate and Meteorology:

The property is in the desert of Northern Sudan where precipitation is infrequent. The climate is arid to semi-arid with a very hot season from May to September during which the maximum temperatures range from 45°C to 50°C and rainstorms and sandstorms may occur. The coolest period covers the months of December and February with daytime temperatures of 30°C and cool nights ranging from 8°C to 15°C. The dominant winds depend on the season: mainly from the west or northwest during the hot period, and from the north or northeast during the rest of the year. Intermittent rainfall can occur during the period from end of July up to October and the number of rain event averages 3-4. The average rainfall is around 30mm and the highest recording was 80mm.

1.4 Socio-economic features and Population (Local Resources)

The region is mainly inhabited by bija tribes mixed with some Arab tribes e.g. Elrashaida. The inhabitants are mainly rearing of the domestic animals such as camels, goats and sheep. Camels and Donkeys are routinely used for loading water from wells or dams on wadis and for transport purposes. Some inhabitants are practicing seasonal agricultural activities in the wadis, depending on the amount of rainfall. And some others work as labors in big cities.

Ecologically extremely marginal and traditionally very drought-prone with little or no infrastructure.

1.5 Physiography

Site is located Near to Wadi Arbaat north of Port Sudan. Region of the site belongs to the Sudan physiographic region and is the central to southern part of the Nubian Desert. The region is characterized by many ragged hills (high relief) and relict mountains in the of Khor Arbaat.

Vegetation consists predominantly of sparse thorny shrubs and dry grasses in the valleys. Grasses cover the valleys for several months after heavy rains, serving as grazing grounds for sheep, goats and camels. The group of acacias can occur.

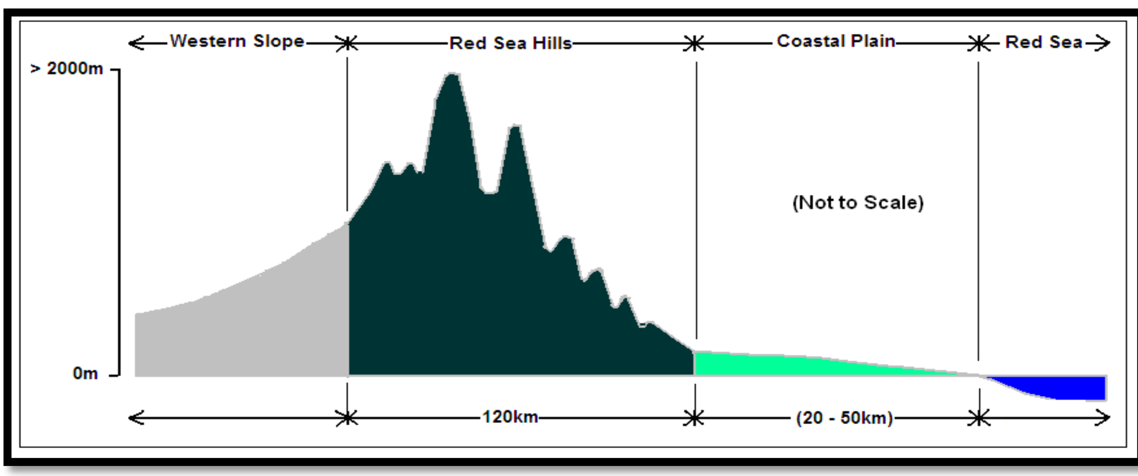


Figure. 1. West-East topographic profile showing the physiographic units

1.6 Vegetation Cover

The scarcity of rainfall influences vegetation cover and its distribution. The dominant vegetation cover in the study area is typified by continental semi-desert and acacia desert species as well as other mountain species (Harrison and Jackson, 1958; Barbour, 1961 and Osman, 1996). The plants are of semiarid zone type, manifested by thorny bushes and acacia trees e.g., acacia species like (Kitir and Salam together with Tundob, Arak, mesquite, and Sidir trees. Ushar plants and small yellow-green phretophyte bushes also are found as an indication of the presence of shallow groundwater. The vegetation cover is distributed along seasonal watercourses (wadis) and in areas receiving run-off. The distribution of vegetation cover is highly controlled by watercourses, soil, topography, runoff, and rainfall.

1.7 Objective of the study

This study represents general investigations in many different aspects of geology including geological mapping, understudying the structural and tectonic setting and minerals exploration. Hence, the main objective of the study is to evaluate the project area in the above-mentioned aspects of geology. The specific objectives are to carry out the following:

The main objective is to carry out Regional geological survey and exploration of the concession area containing the main geological elements (lithological, structural and mineralization zone), dealing with the geological and potentiality of gold mineralization, associated minerals, structural setting and related gold occurrences.

This study represents site investigation and potentiality evaluation stage of the geological exploration investigations for the gold occurrences in the concession area based on the remote sensing studied and field work survey. This investigation is supposed to shed light on the type of mineralization of the gold and associated minerals in the concession, potential zones and sectors, which consequently allows the recommendation of appropriate detailed exploration that will follow.

The fieldwork has been conducted in the concession area during December 2024. General geological exploration and chip channel sampling for each exposed and available ore in concession block.

2- Methods of Investigation

Different methods have been conducted during this study to achieve the objectives stated in the previously. Remote sensing investigations represent the corner stone of this study.In this study GIS- Geo-database technology was developed as an integrated approach to amalgamate the various products of digitally processed remote sensing data, geochemical data, office mapping and field work data all together. Generally, the plan of work was designed to be conducted in four stages which are:

- Stage I: Pre-fieldwork Investigations.
- Stage II: Fieldwork Investigations.
- Stage III: sample Preparations and Laboratory Investigations.
- Stage IV: Office and Laboratorial work.

2. I- Pre field work Investigations:

This stage consists of two parts the first one deal with data collection and literature review for the area of interest and adjacent regions. The other part concerning with remote sensing investigations. The main target here is to prepare base layers and maps, including the geological, structural, drainage and topographic maps later on.

2.1.1. Remote Sensing data:

Remote sensing studies have been utilized in the present investigations using the optical satellite imageries of Landsat 8 OLI instrument

Remote sensing studies aim to reveal the geological, topographical aspects of the area, as well as to decipher the main lineaments and lithological units. Various digital image processing procedures have been attempted in order to the increase the interpretability of the images in a way facilitating the differentiation between the different lithological units. To this end, a package of digital image processing was applied upon the Landsat image, e.g. colour compositing, and decorrelation stretching.

High resolution image was prepared for the current detailed investigations at the prospect scale. This image is fused with the panchromatic band in order to produce a relatively higher spatial and spectral resolution data set suitable for the intended task. Hard copy versions of the digitally enhanced satellite images were used in the field as a base map for direct plot of geological boundaries and structural measurement.

These maps were also fed into a computer attached to a hand held GPS which were all used together for navigation to the traverses and waypoints along them. Examples of the prepared images include the creation of a colour composite from Landsat 8 OLI image using the band combination of 752 in RGB, respectively (Figure. 3). This images discriminate the different lithologies to an acceptable degree. The digitally processed data of Landsat imageries paved the way for the geological studies in the Block and reduced both the time span and costs of the field work

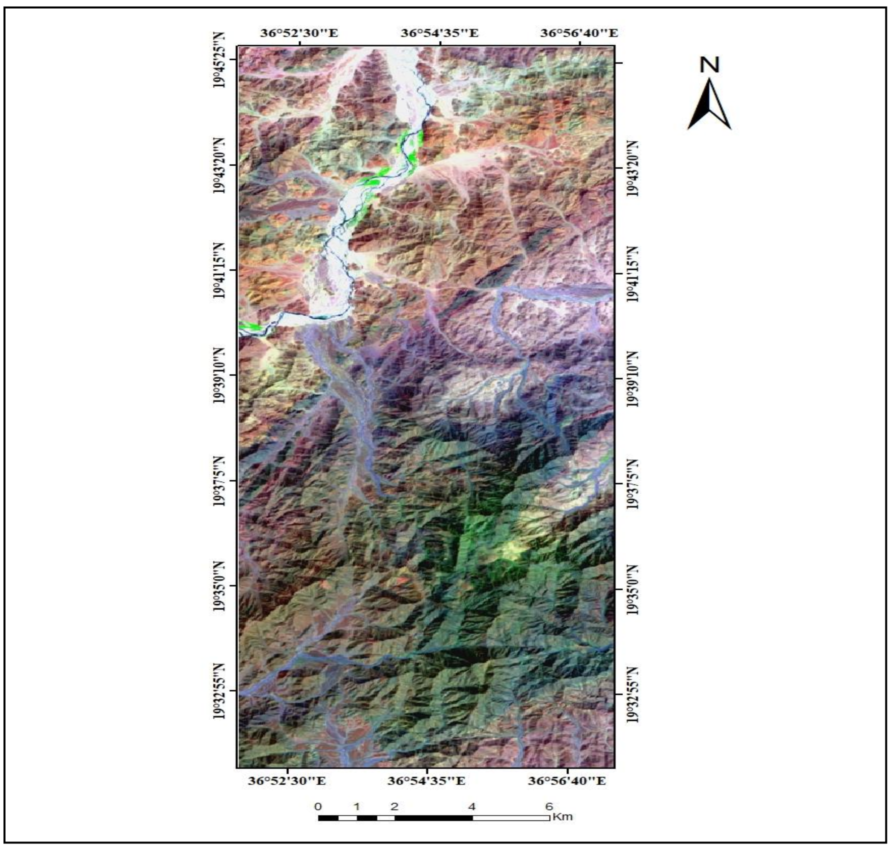


Figure (3): Colour composite image obtained using bands 752 in RGB, respectively

Principal Component Analysis (PCA)

Principal component analysis often called PCA, or Karhunen- Loeve analysis. The transformation of the raw data using PCA can result in new principal component images that are more interpretable than the original data (Jensen, 1996). The PCA is used to compress the information content of a number of bands of imagery or to reduce the dimensionality from a number of bands to two or three PCs (Jensen, 1996). It is also used to reduce the redundancy of information in highly correlated image set.

Using the six reflected multispectral bands of landsat 8 OLI , PCA have been performed over the study area. This procedure has resulted in the production of six principal component images.

Firstly, this analysis was applied to the six Landsat 8 bands (2, 3, 4, 5, 6, and 7).This result allowed to identify which PC contains more useful spectral information from Landsat 8 bands which has much higher contrast than the original bands.

The first three principal components (PC1, PC2 and PC3) were then combined to create a color composite by assigning the first principal component to Red, the second one to Green and the third to Blue filters. The obtained PCA colour composite is displayed in (Fig 4). This image show the hydrothermal alteration in light green color

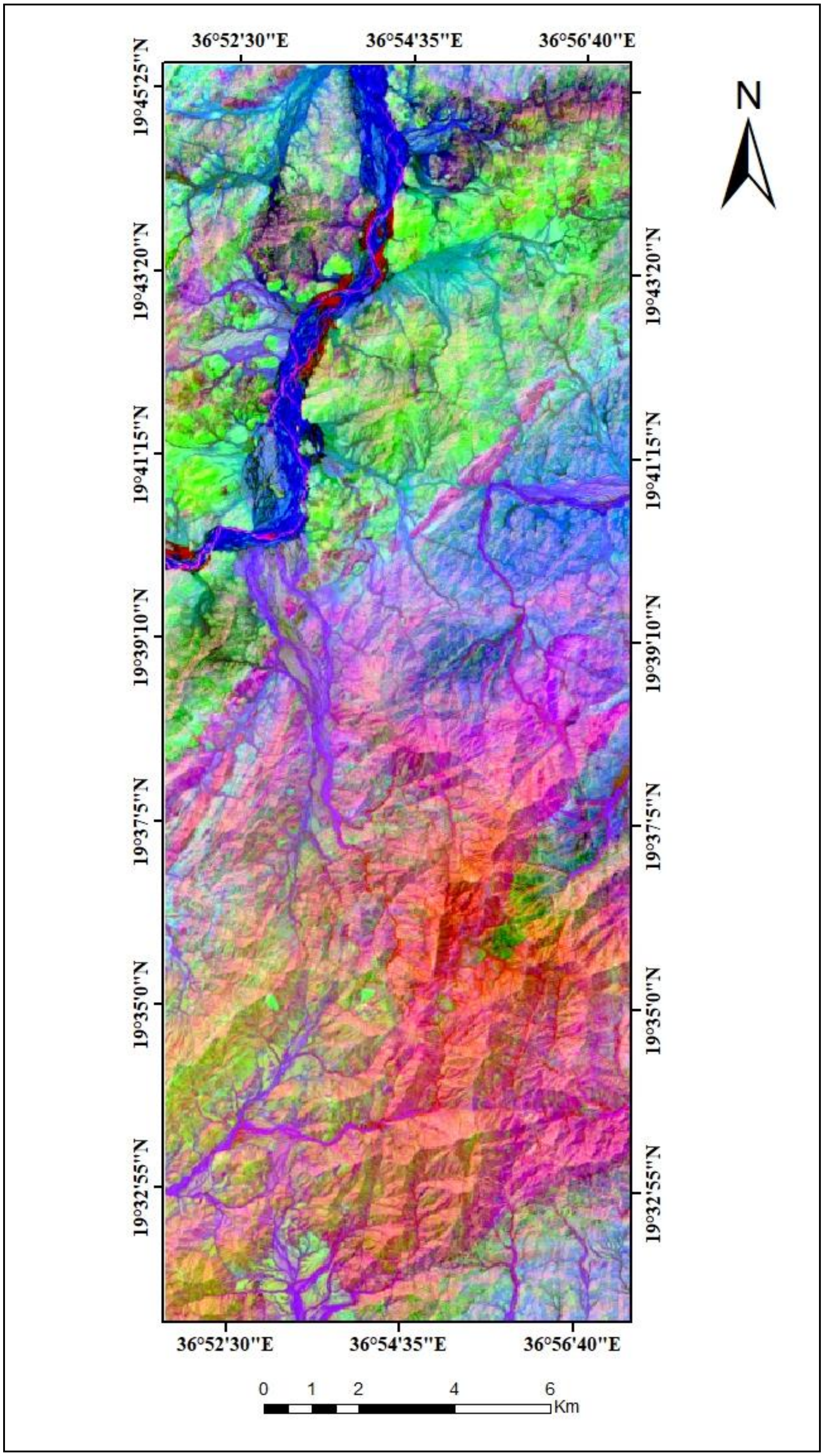


Figure (4): Principal component analysis color composite obtained by assigning PC1, PC2, PC3 to RGB, respectively.

In this study, it was carried out the Crosta technique (Crosta and Moore, 1987), where the Eigenvector statistics output of PCA was analysed in way to identify the PC that contains the spectral information of the target minerals. These selected PC images could then show the targeted minerals by highlighting them as bright or dark pixels, according to the magnitude and sign of the Eigenvector Loadings.

For mapping iron oxides, Landsat 8 bands 2, 4, 5, and 6 were used and for hydroxyl bearing minerals Landsat 8 bands 2, 5, 6, and 7 were used.

An image displaying pixels with anomalous concentration in hydroxyl and iron oxides bearing minerals as brightest pixels was created by merging of hydroxyl bearing image and iron oxide bearing image, by using Crosta technique. This new image was combined with the other two in a RGB composite (Iron oxide bearing image, iron oxide and hydroxyl bearing image, hydroxyl bearing image). A colour image resulted where bright pixels within alteration zones are areas where both iron stained and argilized; bright reddish to dark orange correspond to areas more argillaceous than iron stained; bright cyan to bluish zones are more iron stained than argilized (Figure 5).

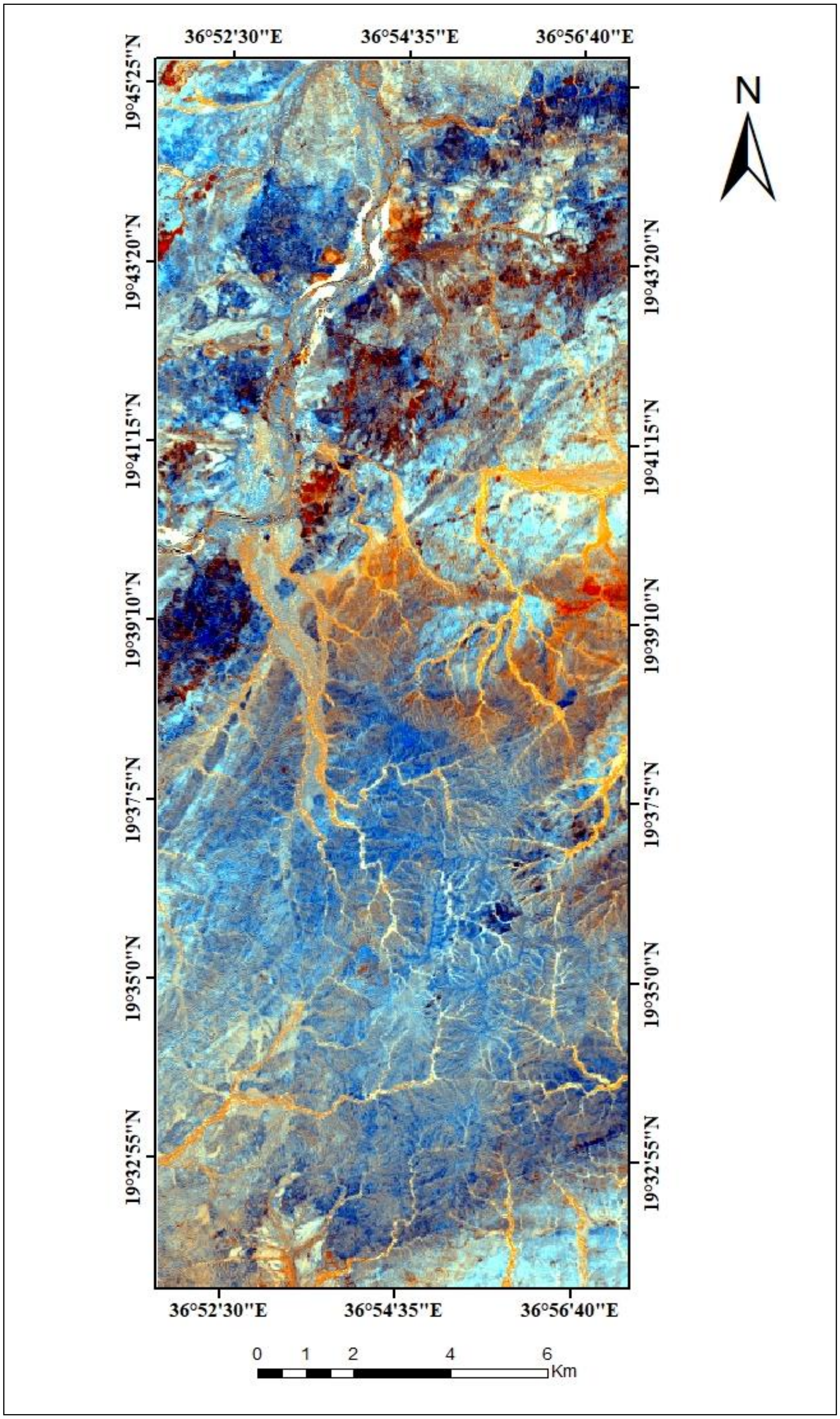


Figure (5) – RGB combination using hydroxyl bearing image, hydroxyl and iron oxide bearing image, and iron oxide bearing image. This composite map the hydrothermal alteration areas.

Band Ratioing

Ratio images are prepared by dividing the DN value in one spectral band by the corresponding DN value in another band for each pixel (Sabins, 2000). It is one of the most commonly used transformations applied to remotely sensed images because certain aspects of the shape of spectral reflectance curves of different earth surface cover types can be brought out by rationing and because the undesired effects on the recorded radiances such as that resulting from the variable illumination caused by variations in topography can be reduced (Mather, 1999).

Ratios images are known for enhancement of spectral contrasts among the bands considered in the rationing and have successfully been used in mapping alteration zones (Segal, 1983; Kenea, 1997).

Different band ratios were tested in this work, in order to enhancing hydrothermally altered rocks and lithological units. The selection of bands are related to the spectral reflectance and position of the absorption bands of the mineral or assemblage of minerals to be mapped.

An image incorporating these band ratios will discriminate altered from unaltered outcrop and highlight areas where concentration of these minerals occurs. An image using Sabin's ratio (4/2, 6/7 and 6/5 as RGB) was produced for lithological mapping and hydrothermal alteration zones (Fig 6). The ratio 4/2 was used for mapping iron oxides as hematite, limonite and jarosite, and has high reflectance in red region. The ratio 6/7 it's used to map clay minerals as kaolinite, illite and montmorillonite. The ratio 6/5 shows high reflectance in presence of ferrous minerals. In this figure the sky blue areas highlights hydrothermal alteration in outcrop rocks.

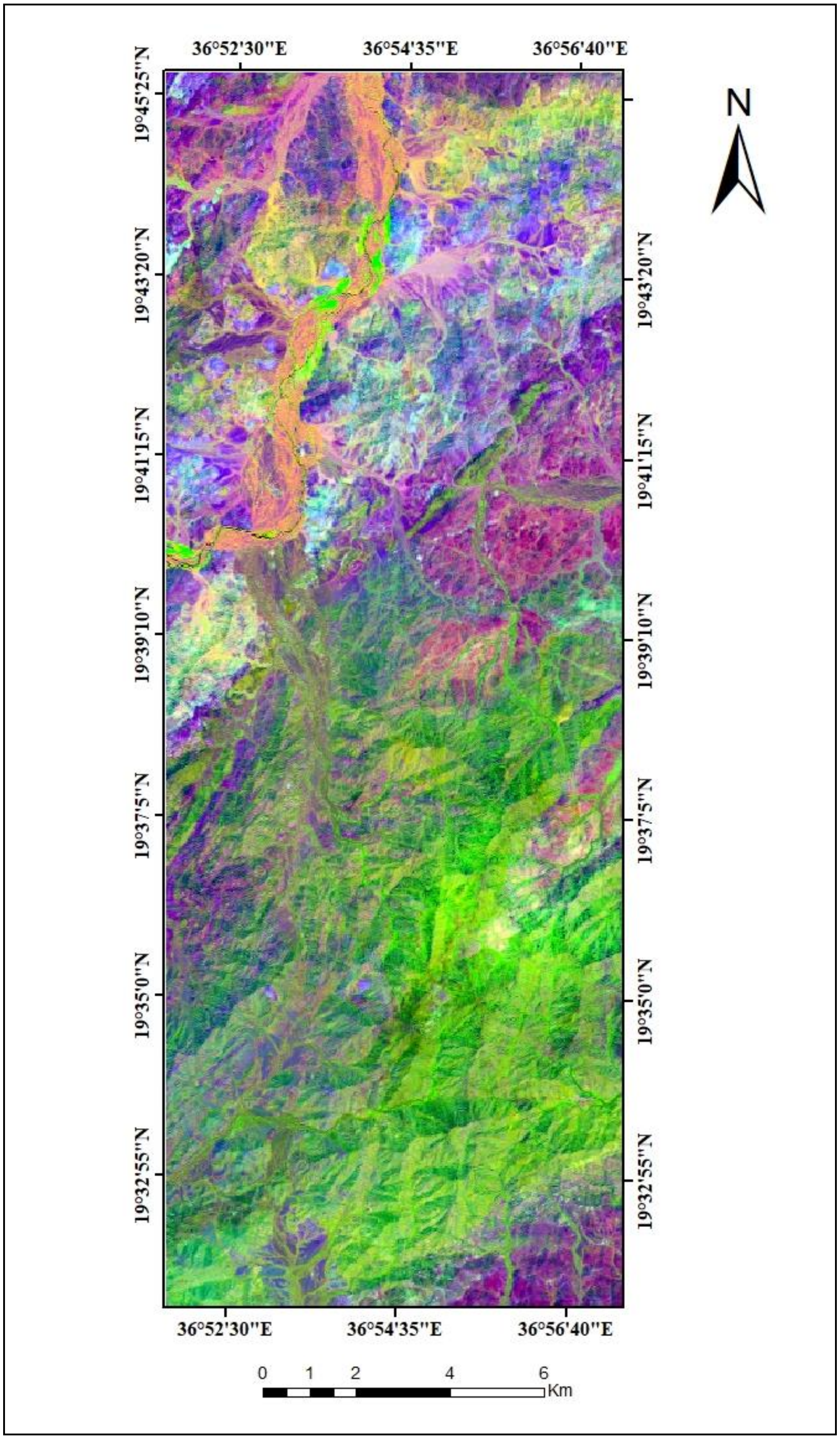


Figure (6): Sabin's ratio image (4/2, 6/7, 6/5). sky green altered rocks.

An additional RGB composite was created with bands (7/5; 5/4; 6/7) in RGB respectively figure (5) that revealed as a good combination for geological purposes. In this image (Figure 7), hydrothermally altered rocks are identified as purple and red.

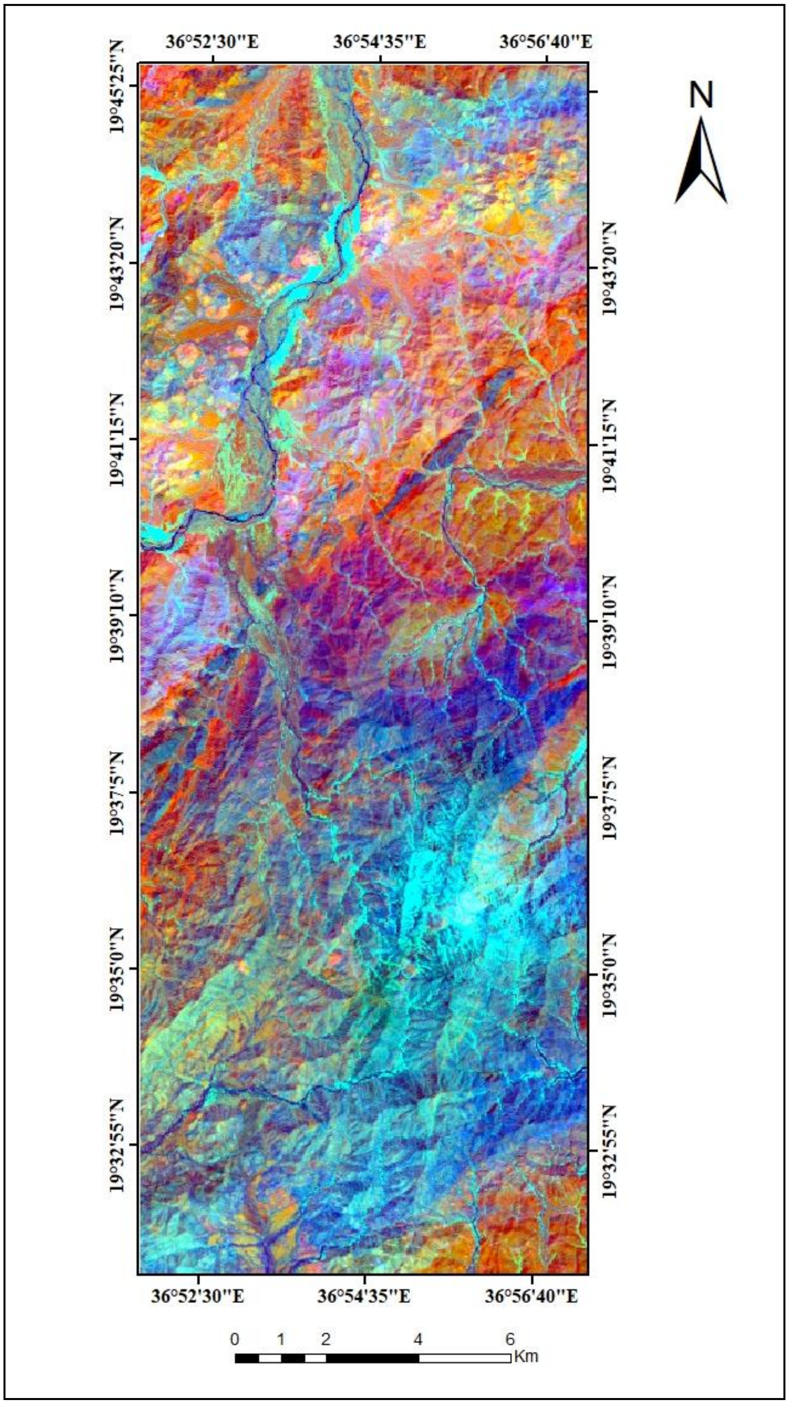


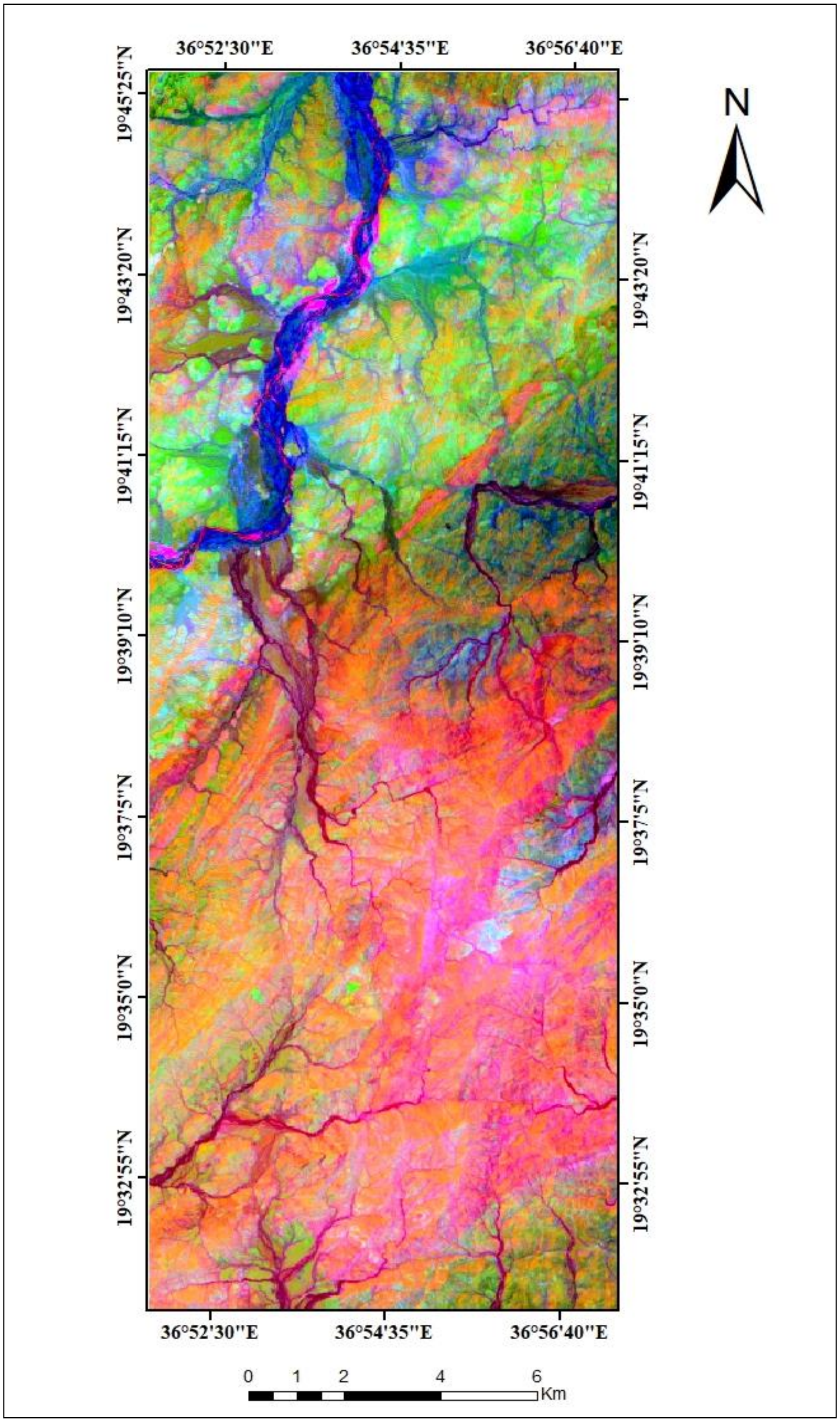
Figure (7): Kaufmann ratio (7/5, 5/4, 6/7). This band ratio combination highlight hydrothermal alteration in red and purple colors.

Minimum Noise Fraction (MNF) Transform

After applying the MNF technique to OLI and ASTER subset data, 7 MNF images of OLI and nine MNF images of ASTER are apparent. A plot of eigenvalues versus MNF band number shows a sharp falloff in eigenvalue magnitude between 1 and 7 for OLI.

Usually the first few MNF bands convey the most information, while subsequent bands increasingly contain noise. The visual inspection of the MNF bands revealed, that a heterogeneous surface composition could also be expected in the study area.

The MNF components of 1, 2 and, 3 are assigned to RGB band combination of Landsat OLI data were assigned to RGB band combination (Figure 8). The results showed that the alteration appear as orange color, the schist as green color in the study area and (Figure 8).



Figure(8): MNF1, MNF2, and MNF3 in RGB of OLI image

3-GEOLOGICAL SETTINGS AND MINERALIZATION

3.1 The Arabian – Nubian Shield

The Arabian Nubian shield (ANS) represents predominantly juvenile continental crust in that it was deformed by differentiation of mantle melts largely without reworking of preexisting continental crust (Stern, 1994). The Sudanese part of the Arabian-Nubian Shield is exposed in the Red Sea Hills of NE Sudan in which the Arbaat area is located.

The ANS represents the northern part of the east African Orogeny, which formed due to collision between east and west Gondwana from this collision the grater Gondwana are formed at the end of Wilson cycle that encompassed most of the Neoproterozoic and defined the pan African orogeny (Stern, 1994).

The Pan-African Orogeny in the Arabian-Nubian Shield is generally considered to span the period 950-550 Ma (Kennedy, 1964; Greenwood, et al. 1976; Kroner, 1984). Rock associations of dismembered arc volcanics and associated intrusive rocks, immature sediments and ophiolites of arc and back arc basin affinities dominate it, which are predominantly in the greenschist facies of metamorphism. Towards the west, they pass into high- grade metamorphic lithologies. This change in metamorphic grade has been interpreted as indicating a pre- Pan- African origin of the high- grade rocks (Vail, 1979; El Nadi, 1984).

The Nubian Shield is composed of a number of terranes (Gerf Terrane, Gabgaba Terrane, Gebeit Terrane, Haya Terrane and Tokar Terrane which are separated by E to NE trending ophiolite-decorated sutures formed during the Pan African Orogeny between 900 –550 Ma ago (Kroner, et al.1987; Fig. (9)

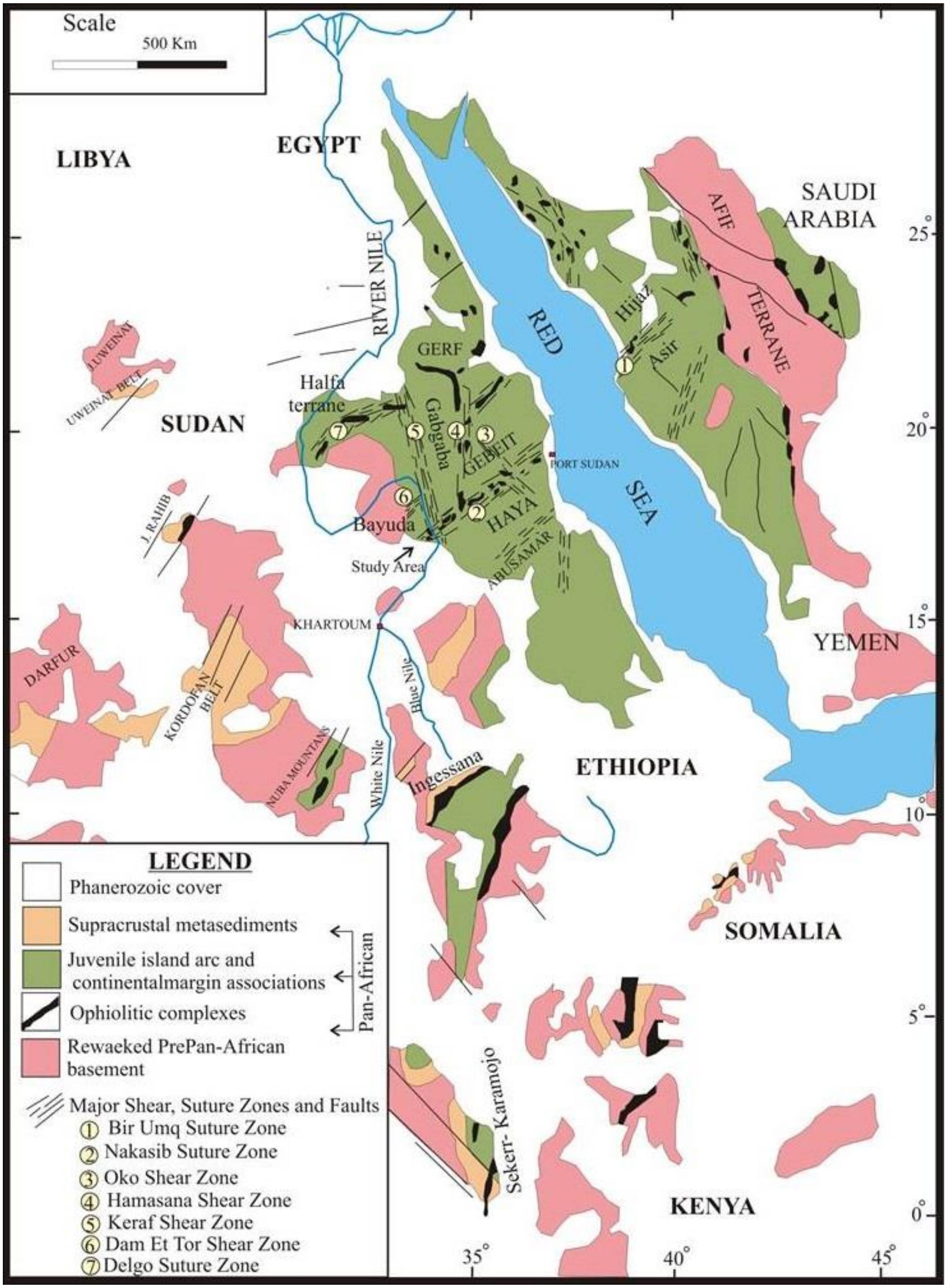


Figure (9): tectonic map show the Precambrian structures, major shear and suture zone.

3.1.1. Lithostratigrphic Unit of the Red Sea Hills

The Red Sea Hills region of NE Sudan is a part of the ANS of Proterozoic era. It lies in the central part of the Nubian segment. It extends northwards through the eastern desert of Egypt and Southwards across the Sudan- Eritrean border into the Ethiopian plateau, to the east is bound by the Red Sea coastal plain and the Nubian Desert to the west. Several have described the geology and subdivided The Basement Complex of the Red Sea Hills of NE Sudan geologists. (Gass, 1955) made the first attempt to classify the basement complex in the Red Sea Hills region into sedimentary-volcanic sequences, batholithic granites and younger granites. (Ruxton, 1956) Sub divided the basement complex of the region into three major sedimentary and volcanic subdivisions with four main periods of igneous intrusions. (Vail, 1979) described the basement complex as green schist assemblage. (Abdelsalam, 1993) described the geology of the southern central part of the Red Sea Hills east of long 35˚30˚along the Nakasib Shear Zone (Table 2).

However, the general description of the rock units has been agreed upon and can be summarized from the oldest are following below respectively.

3.1.1.1 High-grade gneisses (Kashabib Series)

This lithological unit was first described by (Gabert. et al, 1960), who named it "Kashabib Series" after the type locality of J. Kashabib. The early workers have regarded them as remnants of ancient continental basement (Ahmed, 1979). Some authors have described them to wide aureoles around granitoids batholiths (Kroner, et al., 1987a), while others have considered the high-grade rocks as local areas of increased deformation and metamorphism within the green schist assemblage (Embleton, et al. 1983).

El Nadi (1984, 1987) interpreted the Kashabib Series as Shelf metasediments of the Nile Craton. The rocks of this unit occur at Sasa plain west of Mohamed Qol village and southeast of Gebeit Mine. These metasediments show clear foliation. Gneissic structure is not always prominent. They include para- gneisses, Para schist in addition to ortho- amphibolites. Their petrography revealed a wide range of mineral composition of the rocks belonging to the unit. Medium-grained Hornblende represents the dominant mineral. Subdominant minerals include quartz and plagioclases (oligoclase –andesine composition) in addition to orthoclase. These rocks were subjected to metamorphism that ranges from the upper to lower amphibolite facies. The medium- to high-grade rocks of this unit are considered to represent the roots of the arc assemblage (El Nadi, 1984 & 1987)

3.1.1.2. Ophiolite Belts

An idealized fully developed ophiolite, as defined by the Penrose Conference in their lithologies and structures (Anon, 1972) consists of serpentinized, peridotite, tectonite overlain by cumulate mafic-ultra mafic rocks which grade upwards into massive gabbros, often with minor plagio- granites, cut by sheeted dolerite dykes, the latter grade into pillowed basaltic lava, with thin veneer of pelagic sediments comprising cherts, shales and minor lime stones. A major rock assemblage in the RSH comprises tectonically dismembered ophiolite complexes that characterize distinct highly strained major shear zones (Vail, 1983; Embleton, et al. 1983; Hussein, et al. 1984; Kroner et al. 1987; Abdel Rahman, et al. 1990b). Most of the complexes display the full range of the ideal ophiolitic lithologies and internal structure, although often no longer in the original stratigraphic order. Many small occurrences lack the diagnostic features to unequivocally identify them as ophiolitic derivatives. Furthermore, extensive serpentinization has profoundly transformed most of the basal units to talc sericite schists and listovenites. Nevertheless, large relatively intact, almost fully developed complexes form linear belts that mark sutures between previously separated terrains. The best preserved and documented examples are the Sol Hamed complex in the northeast (Fitches et al., 1983), the J. Gerf and W. Allaqi complexes in the north (Kroner, et al. 1987). The Onib and W. Sudi in the northwest (Hussein, et al. 1984), and the Nakasib Ophiolite at the center of the region (Embleton, et al. 1983).

3.1.1.3. Lower Volcano sedimentary Units (Nafirdeib Series)

The most extensive exposure of this unit in the Red Sea Hills occur in the Gebeit terrane the volcanic rocks range in composition from basalt and basaltic-andesite to andesite and Rhyolite which have calc- alkaline affinity (El Nadi, 1989). The metamorphic grade for this lithological unit is a low – to medium grade (greenschist to epidote - amphibolite facies). Kröner, et al. (1987) correlated the whole Gebeit volcanic terrain with the 700- 850 Ma old Hijaz arc of western Arabia as interpreted by Camp (1984). He suggested that Gebeit arc volcanic and the Hijaz arc form a broad NE trending arc complex.

3.1.1.4.Upper Volcanosedimentary Unit (Awat Series)

To designate the volcano - sedimentary sequence unconformably overlying the Nafirdeib series, the upper volcano - sedimentary unit has been previously named Awat series by Ruxton (1956). The volcanic part of this unit is dominantly acidic which includes Rhyolite, rhyodacites and dacites constitute the major lithologies in addition to Ignimbrites and other acidic pyroclastics. The sedimentary part of the upper volcano-sedimentary unit comprises siltstone, greywackes, red conglomerates, Limestones, quartzites and mudstones. The rocks of this unit are less altered, less metamorphosed and less deformed compared to the lower volcanosedimentary unit. The dating the Awat volcanic sequence on the basis of presumed contemporaneous intrusives at 740 Ma (Embleton, et al. 1983). This unit was correlated with the molasses-type sediments of the Hammamat group of eastern Egypt (Ries, et al. 1983) and the J. Balah group in Saudi Arabia (Delfour, 1970). The geochemistry revealed calc-alkaline affinity, indicating that they are subduction related volcanic (El Nadi, 1984).

3.1.1.5 The Syn - to late- orogenic intrusions

They are heterogeneous batholiths of calc-alkaline rocks, which range in composition from gabbros to diorites, granodiorites and Granites. Tonalities and adamellites are less common. The calc- alkaline geochemical affinities characteristically indicate a sub duction related geotectonic environment. An age of 815 - 724 Ma has been assigned for the syn - collisional intrusives by (Klemenic & Pooles 1988). Brown (1980) suggested that the syn - to late-tectonic batholiths of the ANS have been emplaced between 960 - 520 Ma age. Foliation is very characteristic of these rocks, where it is emphasized by the alignment of the phenocrysts of K- feldspars, hornblende and biotite. Rocks of this group are usually chloritized and epidotized. They occur as high rugged mountains but when they suffer from deep weathering they appear as subdued oval sandy plains.

3.1.1.6. The post- orogenic intrusions

The post- orogenic intrusions are characteristically bimodal (gabbro –granite) complexes giving way to alkaline Granites and syenites, with evidence of high level emplacement and the development of ring structures (Neary, et. al. 1976). The emplacement of the post-orogenic plutons is thought to be related to crustal relaxation which accompanied basement uplifting that followed the cessation of the accretion tectonics (Kenea, 1997).

3.1.1.7 Dyke swarms

Represent one of the most striking igneous features exhibited by the Red Sea Hills terrain. They invade the whole older lithostratigrphic units at different times and have different directions. Abu Fatima (1992) classified the dyke swarms into two major groups: older dykes and younger dykes. The older dykes were mostly emplaced at 600 - 700 Ma, mainly less than 4 meter thick, and many are related to nearby igneous complexes, while some are likely to be feeders of the volcanic in the area (Babiker and Gudmundsson, 2004). According to Abu Fatima, (1992) the age of the younger dykes is 130 -140Ma, and their thickness may reach 30 m and they commonly form conspicuous ridges. The dyke swarms range in composition from acidic to mafic lithologies including granite, microgranite, Rhyolite, granodiorite, diorite Gabbro and basalt. The major trends are NE, ENE, NNE and NNW. Other common trends are NW, E-W and to a lesser extent N-S.

3.1.1.8 Cenozoic Sediments

This group comprised the siliciclastic and shallow marine, rift-related Cenozoic sediments have been witnessed all along the Sudanese coastal plain, both in drilled boreholes and as surface outcrops. They have a maximum thickness of 4162m as encountered in Durwara II well, 70 km south of Portsudan. They have been divided into: Mukawar Formation, Hamamit Formation, Maghersum Formation, Khor Eit Formation, Abu Imama Formation and Dungunab Formation, in addition to the older gravel (Sestini, 1965). Bunter and Abdel Magid (1989) have recognized the close similarities between the gulf of Sues sediments and those of the Sudanese Littoral zone. They discussed the tectonic and paleogeographic evolution of the Red Sea-Gulf of Suiz graben and divided it into two major tectonic phases; pre-rift and syn-rift and further divided the latter phase into syn-rift pre-salt and syn-rift post-salt phases. These sediments vary from Upper Cretaceous continental sandstone, Eo- Oligo-Miocene shallow marine limestones to thick Miocene evaporites sequences with coarse - to fine - clastic sediments. The older gravels unit (a few to 25m thick), unconformably overlies the Miocene sediments and they represent the different alluvial fan cycles that occurred during the Pliocene-Pleistocene time. The emergent Pleistocene reefs occur as linear terraces, running parallel to the shoreline. Four distinct reef terraces have been identified by Sestini (1965). Their formation was attributed to eustatic changes in sea – level (Whiteman, 1971; Babikir, 1994).

3.1.1.9. Tertiary volcanics and related minor intrusions

The Cenozoic volcanics are widespread in east Africa, especially in Egypt, Ethiopia and east and north central Sudan, (Vail, 1971, 1973; Almond, et al. 1977). Firstly, these volcanics were described them in more detail and related them to Tertiary-Quaternary volcanic activity (Andrew, (1948); Vail (1971); Almond, et al. (1969 & 1977).

These volcanics have been reported from various localities within the Red Sea hills terrain (Gass, 1955; Kabish, 1962; Whiteman, 1968; and El Nadi, 1984). Some of them have been related to the Red Sea Rift (Vail, 1978), while others have been considered to be part of the Ethiopian volcanic plateau. The available field radiometric evidence is sparse but sufficient to show that the volcanicity in north and northeastern Sudan began in upper Cretaceous times and continued until the recent (Almond, et. al. 1984). Related dykes and sills are mainly basaltic in composition.

3.1.1.10 Recent Sediments

All the lithology mentioned above are covered by Quaternary to Recent sediments. They occur as a result of the interaction between the Aeolian and fluvial sedimentary processes acting within the Red Sea hills terrain Alluvial fans, wadies deposits and fan-delta deposits represent the products of the fluvial processes. These sediments include gravels, sands, clays, sandy clays and silt.

Table 2. Lithostratigrphic Units of the Red Sea Hill

	(9) Unconsolidated sedimentary cover (Recent) + Costal sediments	Post pan African Mainly Mesozoic Tertiary < 500 Ma
	(8) Cenozoic volcanics	
Syenite Granite Gabbro	(7) Anorogenic (ring complexes)	
Syenite Granite Gabbro	(6) Post-late orogenic intrusives (batholithic)	Intrusive Pan-African 890-500 Ma
Mainly granites and granodiorites	(5) Early or Syn-orogenic Granitoids	
Greenschist facies	(4) Metavolcano- sedimentary Assemblage Thrust	Pan-African 900-500 Ma
Imbricated in the unit 4	(3) Ophiolitic complexes	
	(2) Amphibolite facies metasediments	Pre-Pan African >1200
	(1) Grey gneisses +granulites	

3.1.2 Structural Framework of Haya Terrane

The Neoproterozoic Arabian –Nubian Shield is characterized by two main types of deformation belts (Abdelsalam and Stern, 1996). The older deformation belts are E- to NE- trending ophiolite-decorated arc – arc sutures formed during collision of intra - oceanic island arc - back arc terranes that occurred between 800 and 700 Ma (Stern, 1994; Abdelsalam and Stern, 1996;). The exception to this is the eastern part of the Arabian Shield where sutures trends NW. The younger deformation belts, which have been referred to as post accretionary structures (Abdelsalam and Stern, 1996), are N- to NW- trending structures and crosscut the arc – arc sutures. These belts were developed in response to shortening of the Arabian – Nubian Shield between the converging fragments of East and West Gondwana. Post-accretionary structures in the Arabian – Nubian Shield consist of (among other structures) N - trending shortening zones in the form of upright folds that developed due to E – W directed shortening at 670 – 610 Ma, and NW- trending sinistral strike-slip faults, that developed at 640 – 560 Ma.

Haya Terrane is a segment of the Nubian Shield, which is formed by accretion of island arc, back- arc terranes and continental micro plates during Neoproterozoic (900 -550 Ma) along E- NE - trending ophiolite decorated sutures (Vail, 1985; Kröner, et al. 1987, 1991; Stern, et al. 1990). The Arabian - Nubian Shield suffered several stages of deformation associated with low- grade greenschist metamorphism, and became fully stabilized during the Pan-African tectono - magmatic stage (ca. 550 Ma). Major ductile shearing along strike-slip zones, transcurrent faulting and overriding tectonic forces from the east or southeast are believed to have caused the major NE-trending structures (folds and faults) in the various Red Sea Hills terranes (e.g. Almond and Ahmed, 1987; Almond and Osman, 1992; Stern, et al. 1989; Lescuyer, et al. 1994). Oblique to, and crosscutting these sutures, are younger (c. 640 - 560 Ma) N- NW- trending left-lateral strike-slip shears (Abdelsalam, 1994).

The Haya terrane appears to be dominated by complex interaction between a wide spread system of ductile shearing and ENE- to NS-trending folding in addition to NW directed brittle shearing and thrusting it is separated from Gebeit terrane by NE - trending Nakasib - Amur suture (Emblton, et al. 1983; Kröner, et al. 1987; Abu Fatima, 1992; Abdel Rahman, 1993; Abdelsalam, 1994) in the north and from Toker terrane by N-S trending Baraka suture in the south .The N- NNW trending Oko Shear Zone affected the northern part of Haya terrane (Abdelsalam, 1994). The ENE trending Khor Ashat Shear Zone divides Haya terrane itself into southern and northern parts. The northern part of Haya terrane is bounded by the Nakasib ophiolitic belt, which extends from north Portsudan in northern Arbaat area. It may represent the western continuation of the Bir Umq ophiolitic belt of Saudi Arabia (Embleton, et al. 1983; Johnson, 2004). The Nakasib suture constitutes a well - defined shear and fold belt with sporadically serpentinized and carbonitized ultra- mafic rocks together with volcanics and sedimentary rocks (Kröner, et al. 1987; Abdelsalam, 1994). Original lithologies and primary structures are still intact in spite of pervasive greenschist facies of metamorphism (Abu Fatima, 1992). The Nakasib suture was modified by sinistral strike slip shearing along N to NW trends typified by the Oko shear zone (Almond and Ahmed, 1987; Abdelsalam, 1994). This sinistral movement of the Oko Shear Zone estimated to be about 30 km (Almond and Ahmed, 1987; Abdelsalam, 1994). Almond and Ahmed (1987) suggested a multistage history for the evolution of the Nakasib suture, while Abdelsalam, et al. (1993) suggested that the Nakasib suture evolved through a complete Wilson Cycle orogeny from rifting, through passive margin formation, to closure of the basin and suturing.

The previous regional studies (Guyot, 1983; Abu Fatima, 1992) of the deformational history of Haya Terrane showed that the area is subjected to at least four phases of deformation in the Pan African age.

D1 is characterized by the development of tight to isoclinal folds with an associated closely spaced axial planar cleavage (Sl). D1 is also characterized, by development of thrusts which tectonically stacked imbricate sheets of the Nakasib ophiolites.

D2 is generally coaxial with D1, and is characterized by the development of tight folds in which both bedding planes (SO) and S1-foliation are folded around NE-trending fold axes. However, the orientations of axial surfaces of these folds are modified by D3 folds. Thrusts which developed during D1 deformation continued to be active during D2.

D3 refolded both D1 and D2 structures and fabrics to produce gentle, nearly upright and horizontal, NE-trending antiforms and synforms, D3 is also responsible for the development of NW-verging thrust.

4. Gold Mineralization Potentialities in (RS-12V) and sampling Results:

The purpose of geochemical measurements is to discover the abnormal chemical patterns or geochemical anomalies related to mineralization (Hawkes and Webb, 1962).The principle of geochemical prospecting is closely linked with mobility and geochemical association of elements.

A hidden ore body can be easily detected by geochemical method, if its constituent elements are relatively mobile. Elements of similar relative mobility tend to occur together under a given set of environmental conditions and some retain characteristic association throughout a wide range of different geological conditions. The presence of one member of such an association can therefore be based as a probable\ presence of the other member that may be difficult to detect.

Since nearly every type of ore is represented by at least one of elements and because of that greater mobility, they invariably from recognizable geochemical dispersion pattern, which could imply the existence of the particular ore being looked for

In the area of block RS12V the artisanal miners as result of continuous work in placer gold mining have caused significant damage to the geological environment, making it no longer permissible to apply the method of collecting samples from the stream and soil sediment samples, so the samples collected only from the Quartz body.

4.1Geochemical survey:

Due to the field survey A total number of 53 samples from 5 targets area mineralization of quartz and alteration chip composite samples were collected from deferent area of concession area shows very encouraging result ranging from (0.1 to 68.91ppm) All samples were analyzed for gold in Chance advanced business Co.Ltd laboratory shows in appendix A.

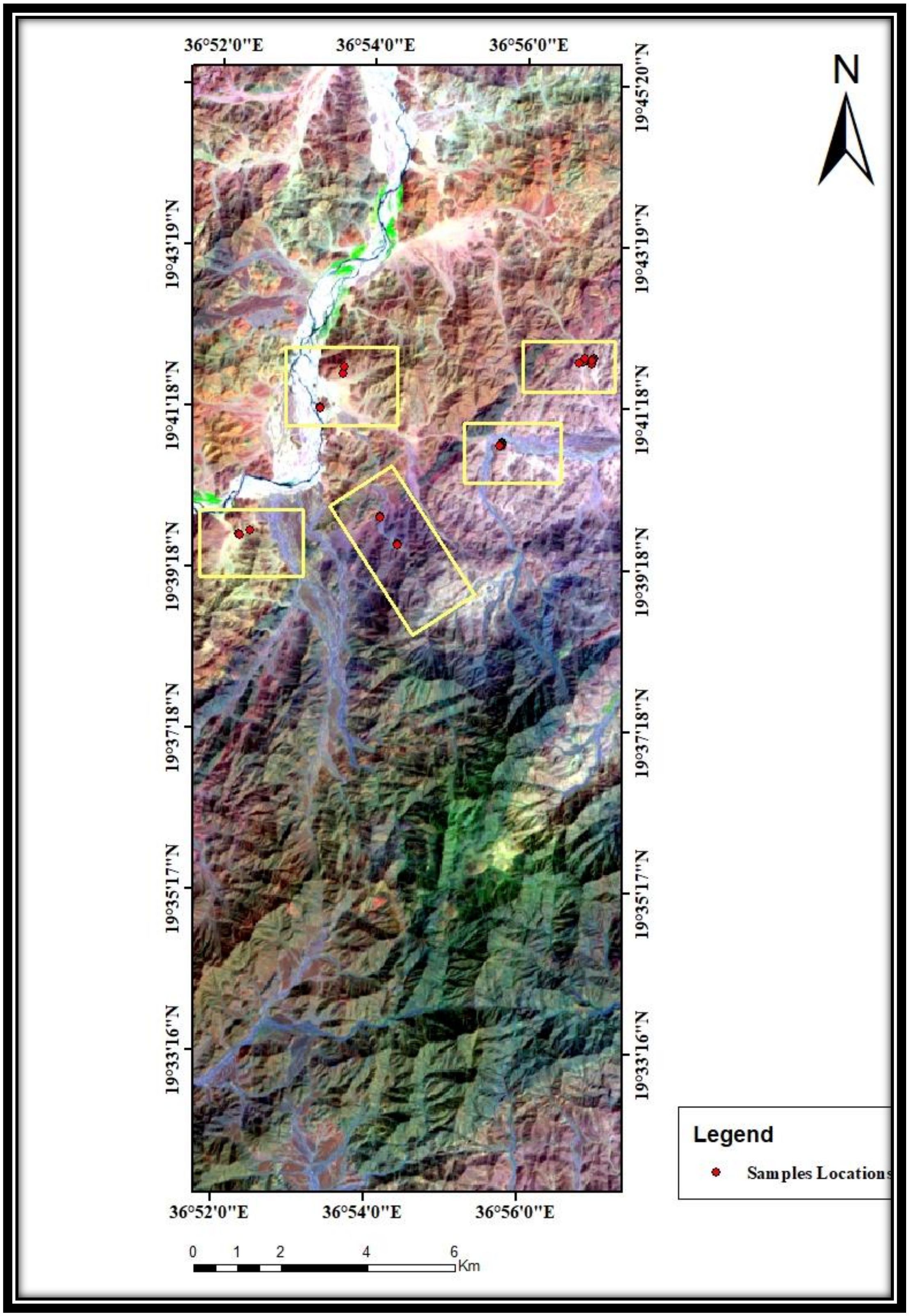


Figure .10. Showing the potential targets and samples location in area of block RS 12V

After taking different types of surface/sub surface samples from the study area and conduct analysis of gold (Au) the plotted analysis values on satellite image of the study area where found gold concentration in several areas have been marked as potential areas (Figure 10) these areas were determined based on promising of the analysis results , field investigations shows distribution of gold concession area. The quartz and alteration chip samples containing gold values above the detection limit is high, about 99% (N=53). The gold is normally The background and threshold values of gold in quartz chip co0mposite samples subjectively after evaluating the geochemical data.

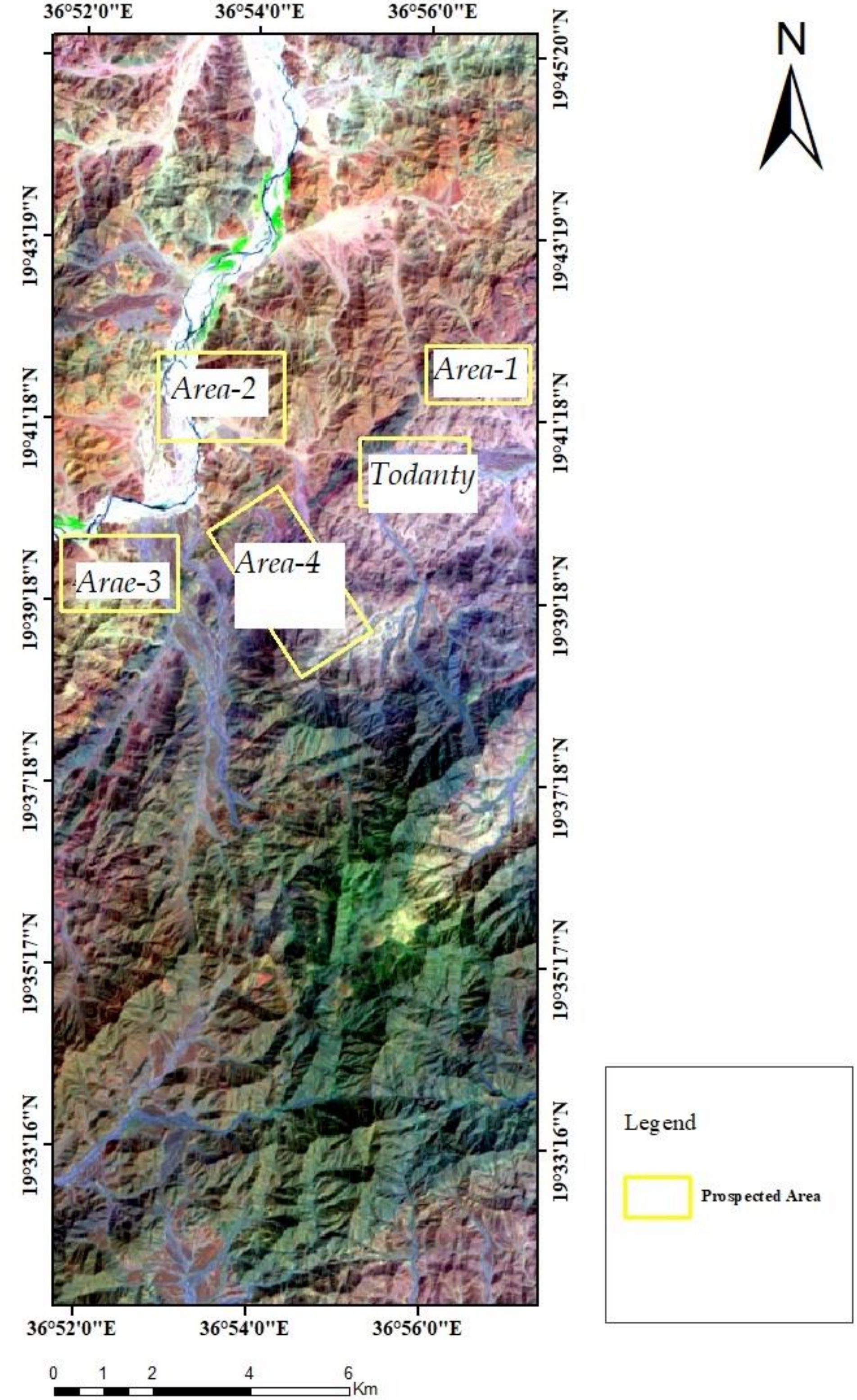


Figure .11. Showing the potential Prospect location on area of block RS 12V

4.1.1Todanty and Area four prospect:

Todanty and Area four prospect located in the west to the south west part of the block the prospect block cover an area of $3km^2$, the area is underlined by sheared low grade meta volcanic -meta diorite rock- intersected by quartz veins and veinlets sub-parallel to the shearing trend, area is mostly artisanal mining sites. in the last mission of the assessment and inspection represent in rock sampling the number of 15 samples has been taken from the exposed Quartz veins and alteration zones from Tdonty prospect which is showing result of sampling activates showing result ranging from (0.09 to 68.91g/t) which can be considered as encouraging results and total of 14 samples collected from area four and is showing sampling result ranging from to(0.03 to 6.17 g/t)

The mineralization in the exploration target of Todanty and the area four covers an area more than (400m) length represents in quartz stringers and quartz vein in some parts. The width of the mineralization on this target is variable, and the width of the mineralization body ranging from 0.2m to more than 1m width in Area4.

Figure .12 an Image Showing the Artisanal activates in area of Todanty

Figure .13 an Image   Showing the Artisanal ore tonnage in area of Todanty

Figure .14 an Image   Showing ore width in area -4

Figure .15 an Image   Showing ore dump in Area -4

4.1.2 Area One prospect:

Area One prospect located in the west to the south west part of the block   the prospect block cover an area of 2.5 km², the area is underlined by sheared low grade meta volcanic -meta diorite rock- intersected by quartz veins and stringers

in the last mission of the assessment and inspection represent in number of 10samples has been taken from the exposed Quartz stringers and vein which is showing result ranging from (0.24 to 18.57g/t) which can be considered as encouraging results , the width of the Quartz ranging from (10cm to 30cm)

Figure .16. An Image   Showing width of the Quartz vein in the Area -1

Figure .17. An Image   Showing the Artisanal work activates in Area -1

4.1.3 Area two prospect:

Area two prospect located in the East to the north east part of the block the prospect block cover an area of 4 km², the area is underlined by grantic rock meta volcanic -meta diorite rock- intersected by quartz veins and stringers

in this mission of the assessment and evaluation total of 9 samples has been taken from the exposed Quartz stringers and vein which is showing result ranging from (0.01 to 13.08g/t) which can be considered as encouraging results , the width of the Quartz ranging from (10cm to 90cm) with alteration zones.

Figure .18. An Image Showing the Artisanal work activates in Area -2

Figure .19. An Image   Showing the width of the Quartz vein   in Area -2

4.1.4 Area three prospect:

Area three prospect located in the East part of the block the prospect block cover an area of 1 km², the area is underlined by grantic rock meta volcanic -meta andesite rock- intersected by quartz veins and stringers with narrow alteration zones.

in this mission of the assessment and evaluation total of 5 samples has been taken from the exposed Quartz stringers and alteration which is showing result ranging from (0.01 to 10.39g/t) which can be considered as encouraging results , the width of the Quartz ranging from (10cm to 20cm) with alteration zones.

Figure .20 An Image Showing the width of the Quartz strangers with alteration in Area -3

5. Summary and Conclusions

BN ENRGY COMPANY LTD dually registered company by the Government of Sudan represent Ministry of Minerals for exploration and exploitation of Gold and associated minerals in block RS-12V in the Red Sea State. The area of study has been investigated during a field trip generally oriented using Remote Sensing techniques and GIS to study the exploration in regional geology integrated with field observation , and geochemical survey to identify potentiality of gold and associated metals mineralization

BN company was awarded (264 Km^2) Concession for exploration and exploitation of Gold & Associated Metals in Block area the area located in the Red Sea State wadi Arbaat locality.

The company has engaged the services to complete the of exploration and block evaluation with professionals who have Excellent experience in the business and implementation of mining operations.

The license area Block (RS-12V) according to the Geological Research Authority of the Republic of Sudan (GRAS) is located in largely underlain by Upper Proterozoic volcano-sedimentary-ophiolitic-granitoid greenschist assemblage intruded by Proterozoic orogenic granitoid batholiths and syn-late tectonic granitoid and gabbroic bodies. These proterozoic structures are mainly covered by quaternary desert sediments,

According to geological works conducted by the Geologist team, throughout all of the license area, especially by reconnaissance geological trips, geochemical sampling and their respectively interpretation; the geological contours of the license area were verify and redefined.

Structurally the concession area effected by deferent phases of deformations (faulting, brecciating, schistosity, and shearing).

It should be clarified that developed map continuously get updated due to the company keeps conducting detail geological works in different locations of the license area.

The 1st stages of exploration activities in the area have shown that the concession Block RS-12V is a potential for large scale gold mining project this is evident from the conducive geological environment, geochemical anomalies and the confirmation of the chip samples taken from the anomalous catchments which explain and verify the interpreted geochemical anomalies.

Detailed exploration work should be executed in the study represents comprehensive investigations in many different aspects of geology including details geological mapping, structural and tectonic setting and minerals exploration represented in ore chip/channel sampling and measuring and evaluation of the exposed Ore

In the area of block RS-12V theirs many artisanal work the method of collecting samples from the quartz vein and stringer

Due to the field survey A total number of 53 samples mineralization of quartz and alteration chip composite samples were collected from deferent area of concession area shows very encouraging result ranging from (0.1 to 68.91ppm) All samples were analyzed for gold in Chance advanced business Co.Ltd laboratory from (0.1 to50.01ppm) all samples were analyzed for gold in RIDA laboratory

6. Recommendations:

As already mentioned in this report the area of Block (RS-12V) considered as potential for large scale gold mining project. The Field trip successfully executed and added value to the project. Consequently certain recommendations should be taken in consideration

- Regional geology and detailed mapping to scale of 1:2000 should be conducted in the potential target areas to enhance the geological understanding of the ore body and structural control to find possible extensions of the ore bodies. High resolution imagery (Geoeye-1, worldview) is recommended to aid the detailed mapping in such well outcropping area.
- Proper trenching and facies channel sampling to obtain accurate information about the ore width and the attitudes are highly recommended in addition to the documentation and mapping to obtain a complete database to the whole data.

• High QA-QC protocols should be followed.

• The anomaly areas recommended for detailed exploration must be surveyed and contoured in details. This is very necessary for accurately locating trenches, mapping, and boreholes sites for further evaluation and resource estimation.

• Generally, the promising results and high confidence of the obtained data and assay for trenching during this year will have an impact in the further detailed geological exploration activities, thus the rework will be applied for trenches to obtain best results and fulfil the sequences and procedures of the mineral geological exploration in Block (RS-12V)

APPENDEX

بسم الله الرحمن الرحيم

Chance

ADVANCED BUISNESS CO.LTD

شركة جانس للاعمال المتقدمة المحدودة

CHANCE ADVANCD BUSINESS CO.LTD

___________________***Result - نتيجة فحص***___________________

أسم العميل : شركة – BN

التاريخ : 2024\12\12

C.R.M_ Acu.C ± 0.07	R.V By_Atom
0.98	**0.94**

_المعمل يستخدم الأحماض (DIBK) في الأستخلاص ونسبة إستخلاصه 100%.

نسبة إستخلاص السيانيد CN-تتراوح ما بين 75_85% إعتمادا علي نوع الخام .

Sample No	Sample Id	Au. g/t
1	RS – A1 – 01	2.90
2	RS – A1 – 02	5.99
3	RS – A1 – 03	18.57
4	RS – A1 – 04	0.34
5	RS – A1 – 05	6.87
6	RS – A1 – 06	1.54
7	RS – A1 – 07	5.57
8	RS – A1 – 08	2.27
9	RS – A1 – 09	0.66
10	RS – A1 – 10	0.24

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Sample No	Sample Id	Au. g/t
1	RS – A4 – 01	1.28
2	RS – A4 – 02	3.17
3	RS – A4 – 03	0.34
4	RS – A4 – 04	0.94
5	RS – A4 – 05	3.88
6	RS – A4 – 06	0.17
7	RS – A4 – 07	0.77
8	RS – A4 – 08	1.40
9	RS – A4 – 09	0.60
10	RS – A4 – 10	0.44
11	RS – A4 – 11	6.17
12	RS – A4 – 12	0.03
13	RS – A4 – 13	1.50
14	RS – A4 - 14	1.23

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Sample No	Sample Id	Au. g/t
1	TD – 01	13.71
2	TD – 02	3.82
3	TD – 03	5.56
4	TD – 04	19.85
5	TD – 05	20.53
6	TD – 06	18.25
7	TD – 07	14.65
8	TD – 08	8.05
9	TD – 09	68.91
10	TD – 10	17.62
11	TD – 11	0.82
12	TD – 12	3.42
13	TD – 13	0.05
14	TD – 14	0.09
15	TD – 15	0.20

1

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التاريخ : 2024\12\12

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0.98	**0.94**

_المعمل يستخدم الأحماض (DIBK) في الأستخلاص ونسبة إستخلاصه 100%.

نسبة إستخلاص السيانيد CN-تتراوح ما بين 75_85% إعتمادا علي نوع الخام .

Sample No	Sample Id	Au. g/t
1	RS – A3 – 01	10.39
2	RS – A3 – 02	0.56
3	RS – A3 – 03	0.36
4	RS – A3 – 04	4.90
5	RS – A3 – 05	9.23

1

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______________________*نتيجة فحص - Result*______________________

أسم العميل : شركة – BN

التاريخ : 2024\12\12

C.R.M_ Acu.C ± 0.07	R.V By_Atom
0.98	0.94

_المعمل يستخدم الأحماض (DIBK) في الأستخلاص ونسبة إستخلاصه 100%.

نسبة إستخلاص السيانيد CN-تتراوح ما بين 75_85% إعتمادا علي نوع الخام .

Sample No	Sample Id	Au. g/t
1	RS – A2 – 01	2.63
2	RS – A2 – 02	0.01
3	RS – A2 – 03	0.00
4	RS – A2 – 04	0.03
5	RS – A2 – 05	0.10
6	RS – A2 – 06	0.20
7	RS – A2 – 07	0.52
8	RS – A2 – 08	13.08
9	RS – A2 – 09	7.65